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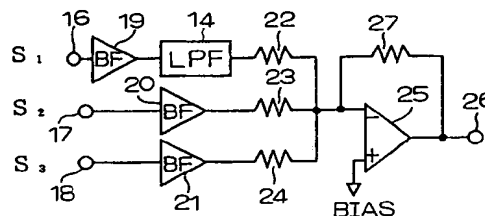
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(54) **Apparatus for generating a sound based on D/A converted analog signal.**

(57) A low pass filter (14) is provided between an input buffer (19) and an input resistor (22) succeeding a first input terminal (16) to which a sound signal converted from digital format to analog format is inputted. After its digital noise is removed by the low pass filter, the sound signal is added to analog sound signals inputted from second and third input terminals (17,18).

Fig. 4



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BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an apparatus for generating a sound based on a D/A converted analog signal such as a game apparatus and an audio apparatus.

2. Description of the Prior Art

Conventionally, an adding circuit for adding a plurality of analog signals, which is used, for example, in an audio apparatus for karaoke, is designed as shown in Fig. 1 such that an internal analog sound signal obtained through a reproduction of a cassette tape is mixed with external analog sound signals inputted from external microphones, and outputted after amplified by an amplifier 1.

Fig. 2 shows a more specific example of a circuit arrangement of such an adding circuit. External analog sound signals inputted to first and second input terminals 2 and 3 and an internal analog sound signal inputted to a third input terminal 4 are inputted through buffers 5, 6 and 7 and input resistors 8, 9 and 10, respectively, to an inverting input terminal of an operational amplifier 11, so that these analog sound signals are mixed and amplified. Then, the signals are outputted to a succeeding sound outputting circuit from an output terminal 12 and released as a sound from a speaker.

Reference numeral 13 represents a feedback resistor having a resistance value R20. In this case, the voltage gain is $V_{OUT}/V_{IN} = -R_{20}/R_{10}$, where R10 represents the resistance value of the input resistors 8, 9 and 10, and VIN and VOUT represent input and output voltages, respectively, .

In recent years, apparatuses of a type are increasingly used which process a sound signal after converting it into digital format and thereafter output a sound signal converted from digital format to analog format (this sound signal will hereinafter be referred to as "digital processing sound signal"). For this reason, it is desired that adding circuits used for such apparatuses are capable of adding analog and digital processing sound signals excellently.

However, the digital processing sound signal converted from digital format to analog format is not a smooth sine wave but includes noise caused by the digitization in its high frequency band (hereinafter referred to as "high band"), and the waveform is distorted in a high-frequency region.

Therefore, if such a digital processing sound signal including noise and wave distortion is inputted to the conventional adding circuit and added, the output sound signal will be distorted and in-

cludes high-band digital noise. This is undesirable.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a sound generating apparatus including an adding circuit for preventing the waveform from being distorted by digital noise in adding a digital processing sound signal to an analog sound signal.

To achieve the above-mentioned object, according to the present invention, in an adding circuit for adding an analog sound signal and a digital processing sound signal converted from digital format to analog format, the digital processing sound signal is passed through a low pass filter before the addition. The adding circuit is used in an apparatus such as a game apparatus and an audio apparatus where a digital processing sound signal is outputted from an internal digital/analog converter.

With such an arrangement, the high-band digital noise included in the digital processing sound signal is removed by the low pass filter before the addition. As a result, in a game apparatus where an external analog sound signal and an internal digital processing sound signal are added and used as an effect sound for a game, a high-quality effect sound is obtained. In an audio apparatus where digital reproduction is performed, an analog sound signal from an external microphone and a digital processing sound signal digital-reproduced inside the apparatus are added and outputted as a high-quality sound.

BRIEF DESCRIPTION OF THE DRAWINGS

This and other objects and features of this invention will become clear from the following description, taken in conjunction with the preferred embodiments with reference to the accompanied drawings in which:

Fig. 1 shows a conventional adding circuit;

Fig. 2 shows a specific example of a circuit arrangement of the conventional adding circuit;

Fig. 3 shows an embodiment of the present invention;

Fig. 4 shows a specific example of a circuit arrangement of the embodiment;

Fig. 5 shows an example of an arrangement of a low pass filter of the embodiment;

Fig. 6 shows an attenuation characteristic of the embodiment;

Fig. 7 shows an example of the embodiment in an optical video disk;

Fig. 8 shows an example of the embodiment in a game apparatus;

Fig. 9 shows how the game apparatus is connected; and

Fig. 10 shows another embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, an embodiment of the present invention will be described with reference to the drawings.

In this embodiment, as shown in Fig. 3, a digital processing sound signal S1 converted from digital format to analog format is mixed with analog signals S2 and S3 after being passed through a low pass filter 14 to thereby remove its digital noise, and is amplified by an amplifier 15 and outputted.

Fig. 4 shows a more specific example of a circuit arrangement of the adding circuit. Reference numeral 16 represents a first input terminal to which the digital processing sound signal S1 is inputted. Reference numerals 17 and 18 represent second and third input terminals to which the analog sound signals S2 and S3 are inputted, respectively. Reference numerals 19, 20 and 21 represent input buffers. Reference numerals 22, 23 and 24 represent input resistors. Between the input buffer 19 and the input resistor 22 succeeding the first input terminal 16, a low pass filter 14 is provided whose cut-off frequency is set to cut high-band digital noise.

Reference numeral 25 represents an operational amplifier. To a non-inverting terminal thereof, a bias is applied, and to an inverting terminal thereof, the sound signals from the input terminals 16, 17 and 18 are inputted. Reference numeral 26 represents an output terminal of the operational amplifier 25. Reference numeral 27 represents a feedback resistor having a resistance value R2. In this case, the voltage gain is $V_{OUT}/V_{IN} = -R_2/R_1$, where R1 represents the resistance values of the input resistors 22, 23 and 24, and VIN and VOUT represent input and output voltages, respectively.

With this arrangement, after its high band digital noise has been cut by the low pass filter 14, the digital processing sound signal S1 inputted to the first input terminal 16 is mixed with the analog sound signals S2 and S3 inputted to the second and third input terminals 17 and 18, and is amplified and outputted. Thereby, an excellent addition sound signal from which digital noise has been removed is obtained from the output terminal 26.

The higher the order of the low pass filter 14 used is, the larger the quantity of the high band attenuation is, and the more the removal of the high band digital noise is ensured. For example, in a third-order low pass filter as shown in Fig. 5 in which a first-order low pass filter 28 with a cut-off frequency of 7kHz and a second-order low pass

filter 29 with a cut-off frequency of 17kHz are combined, as shown by a dash and dotted line in Fig. 6, a high band of 7kHz and above is attenuated by the first-order low pass filter 28 by 6dB/OCT and a high band of 17kHz and above is attenuated by the succeeding second-order low pass filter 29 by 12dB/OCT. Then, the fall of the high band attenuation is steeper than that of the normal attenuation characteristic shown by the solid line in Fig. 6.

Fig. 7 shows an example of such an adding circuit realized in the form of an IC incorporated in an optical video disk apparatus for karaoke. To a first input terminal 30A of an IC device 30, a digital processing sound signal S1 is inputted which is digital-reproduced from a video disk and converted to analog format by a digital/analog converter 31. To second and third input terminals 30B and 30C, the analog sound signals S2 and S3 from external microphones for duet are inputted. The addition sound signal formed by adding the digital processing sound signal S1 and the analog sound signals S2 and S3 is outputted from an output terminal 30D to a sound outputting circuit 32 and released from a speaker 33.

Fig. 8 shows an example of the adding circuit realized in the form of an IC incorporated in a household game apparatus 35 connected to a television receiver 34 as shown in Fig. 9. To a first input terminal 36A of an IC device 36, a digital sound processing signal from a digital/analog converter 37 incorporated in the game apparatus 35 is inputted. To a second input terminal 36B, an analog sound signal from a game software apparatus (read only memory [ROM] cassette) 38 inserted into the game apparatus 35 from the upside is inputted. To a third input terminal 36C, an analog sound signal from an external input terminal of the game apparatus 35 is inputted. The addition signal formed by adding the digital processing sound signal and the analog sound signals is outputted through a signal line 39 to a sound outputting circuit 40 provided in the television receiver 34, and released from a speaker 41.

Reference numeral 42 represents a power transmitting cord. Reference numeral 43 represents a power-on key. Reference numerals 44 and 45 represent operation portions for playing games, each of which has an operation button.

Fig. 10 shows an example of the adding circuit realized in the form of an IC in which a non-inverting type operational amplifier 46 is used. In this case, the voltage gain is $V_{OUT}/V_{IN} = (R_3 + R_4)/R_3$, where R3 and R4 represent the resistance values of the resistors 47 and 48, respectively.

By realizing the adding circuit in the form of an IC as described above, the incorporation of the

circuit into an apparatus is facilitated. By covering the IC with a shielding member, the intrusion of digital noise from a digital sound circuit portion on the same circuit board is prevented.

As described above, according to the present invention, since a digital processing sound signal converted from digital format to analog format is added to an analog sound signal after being passed through a low pass filter, an excellent addition sound signal from which digital noise included in the digital processing sound signal has been removed is obtained. For example, in a game apparatus where a digital processing sound signal and an analog sound signal are added and used as an effect sound for a game, a high-quality effect sound is obtained.

Obviously, many modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced other than as specifically described.

Claims

1. An apparatus comprising:
 - means for supplying a first sound signal of analog format;
 - means for supplying a second sound signal converted from digital format to analog format;
 - a low-pass filter for removing a high band noise from the second sound signal;
 - adding means for adding the first sound signal and the second sound signal outputted from the low pass filter;
 - sound releasing means; and
 - means for driving the sound releasing means based on an output from the adding means.
2. An apparatus according to claim 1, wherein said apparatus is a karaoke apparatus.
3. An apparatus according to claim 1, wherein said apparatus is a game apparatus.
4. An apparatus according to claim 1, wherein said low pass filter and said adding means are in the form of integrated circuits.
5. A device comprising:
 - a first terminal for receiving a first sound signal of analog format;
 - a second terminal for receiving a second sound signal converted from digital format to analog format;
 - a low pass filter connected to the second

terminal;

an adding circuit connected to the first terminal and the low pass filter; and

an output terminal to which an output from the adding circuit is directed.

Fig. 1

P r i o r A r t

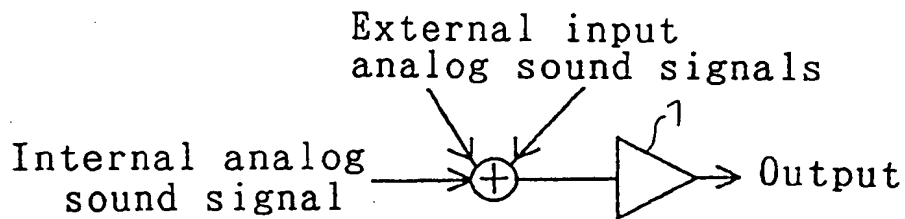


Fig. 2

P r i o r A r t

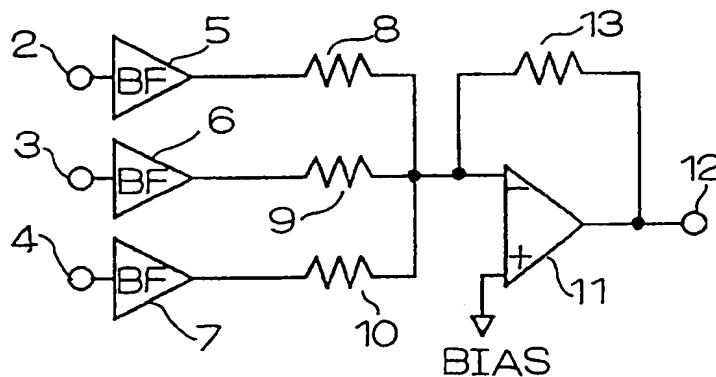


Fig. 3

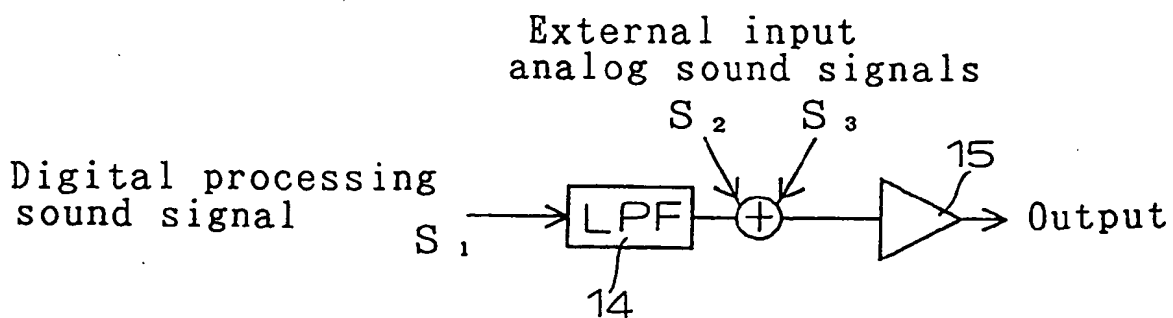


Fig. 4

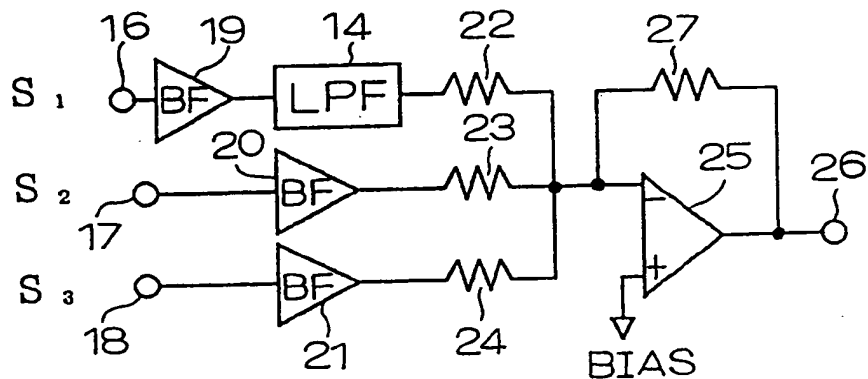


Fig. 5

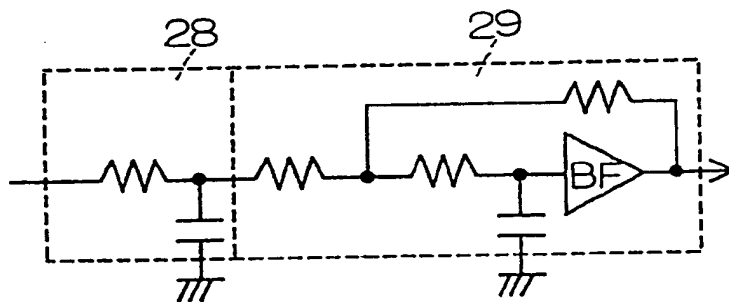
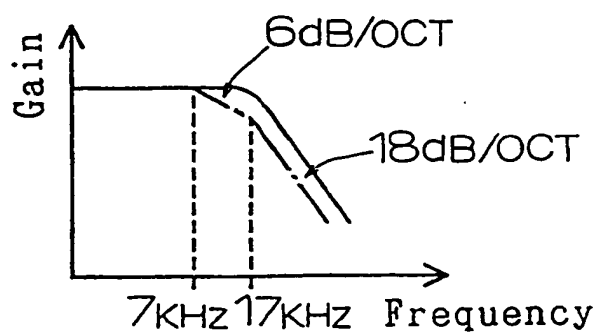


Fig. 6



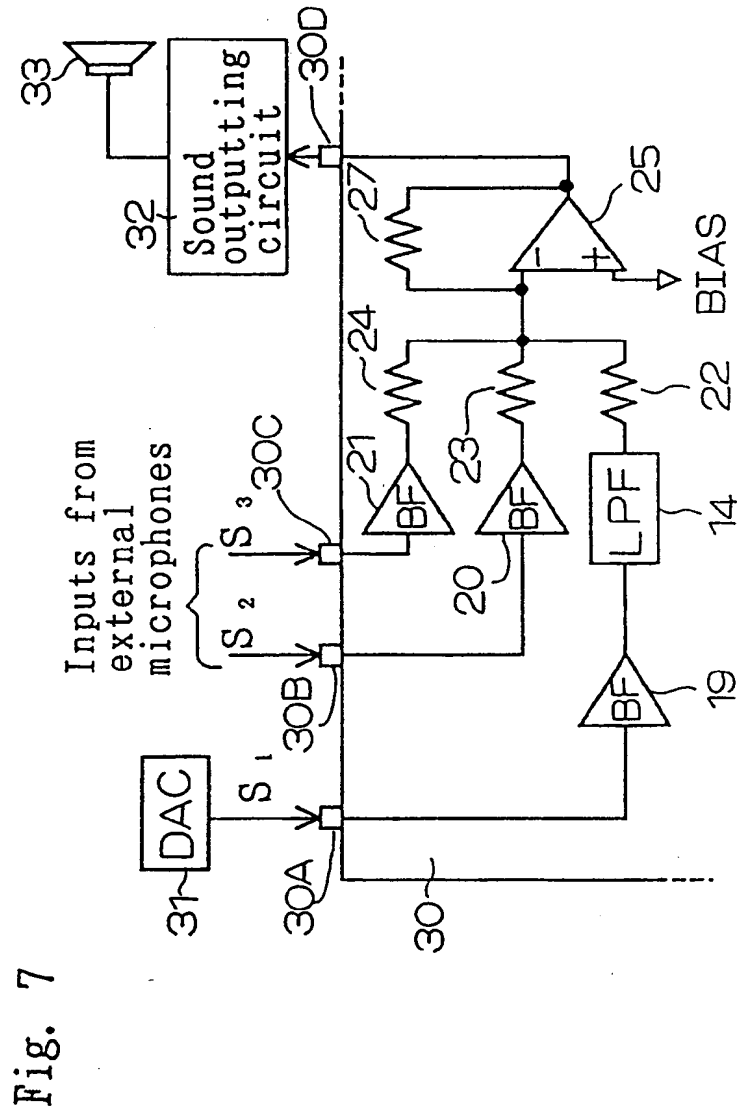


Fig. 8

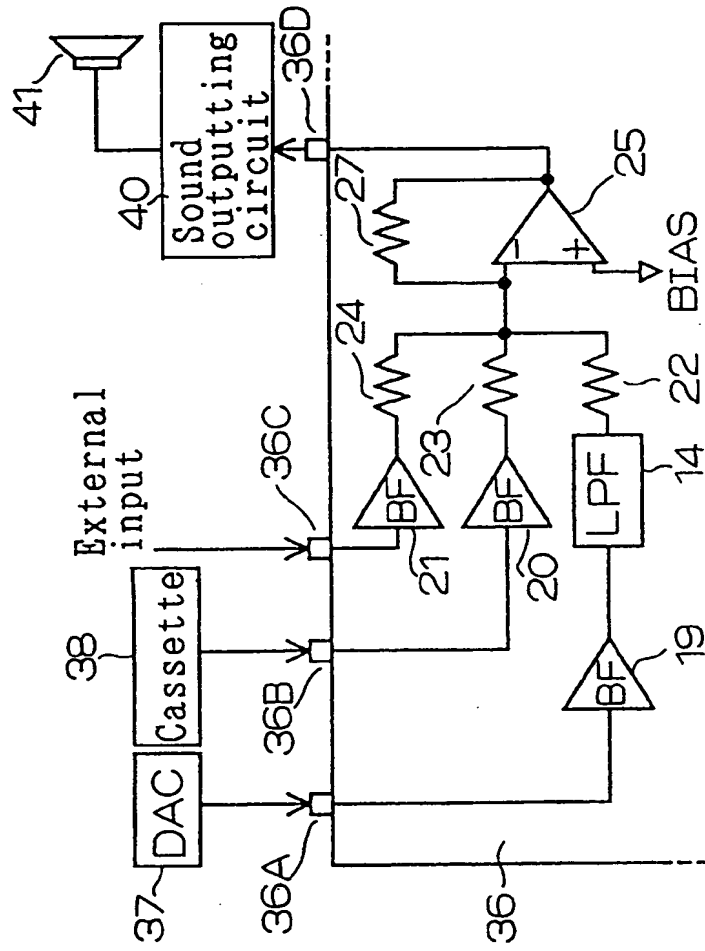


Fig. 9

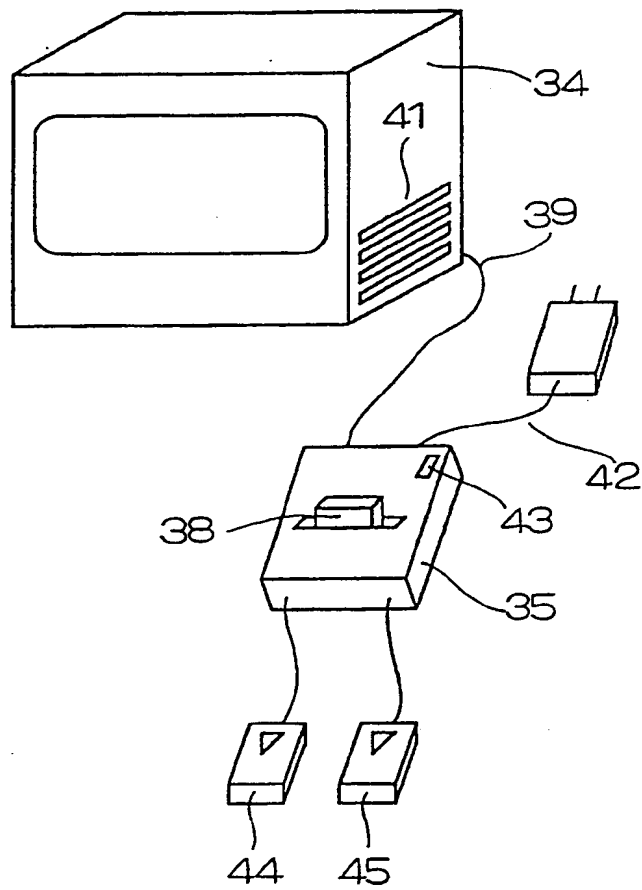
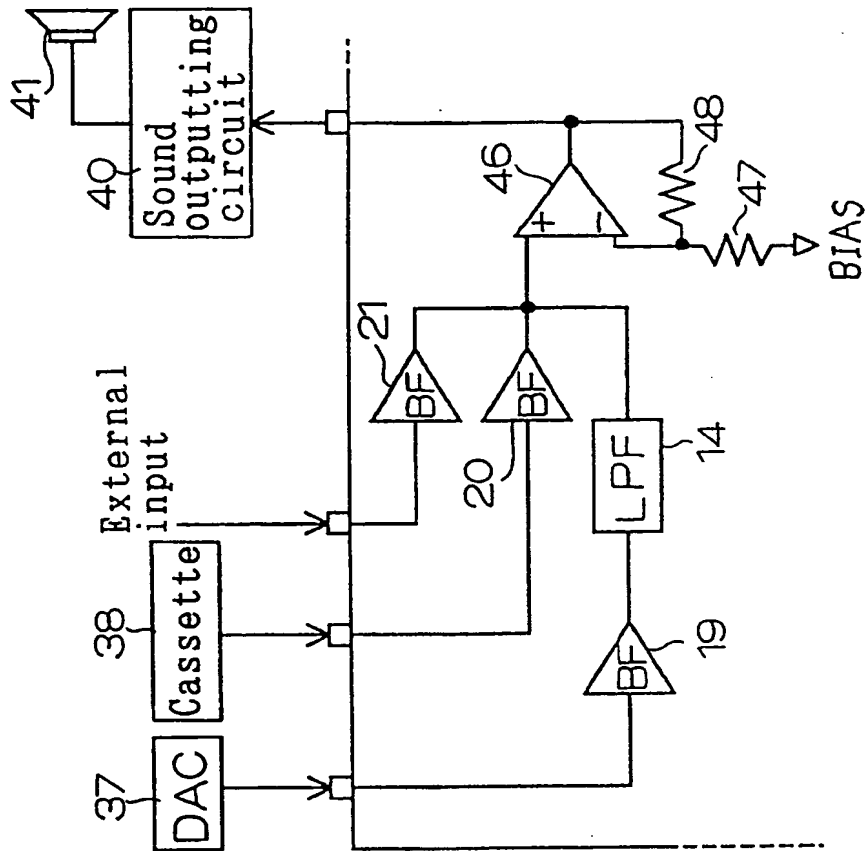


Fig. 10





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EUROPEAN SEARCH REPORT

Application Number
EP 94 10 4101

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
A	US-A-5 131 311 (MURAKAMI ET AL.) * column 1, line 62 - column 2, line 66; figure 1 *	1,2,5	G10H1/08 G10H1/12 G10H5/00
A	DE-A-40 35 408 (PIONEER ELECTRONIC CORP.) * column 3, line 10 - line 50; figure 1 *	1	
A	GB-A-2 213 003 (LYNETT SYSTEMS LTD) * page 11, line 17 - page 12, line 6; figure 2 *	1	
A	WO-A-88 05200 (BREAKAWAY TECHNOLOGIES INC) * page 7, line 11 - page 9, line 28; figure 1 *	1,2	
			TECHNICAL FIELDS SEARCHED (Int.Cl.5)
			G10H
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 27 May 1994	Examiner Pulluard, R
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